The Claims

What is claimed is:

1. A composite-type mixed oxygen ion and electronic conductor, characterized in that its oxygen ion conductive phase consists of gadolinium-doped cerium oxide (composition formula: $Ce_{1-x}Gd_xO_{2-x/2}$, where $0<x<0.5$), and its electronic conductive phase consists of spinel-type ferrite (composition formula: MFe_2O_4, where M=Mn, Fe, Co, or Ni).

2. A composite-type mixed oxygen ion and electronic conductor, characterized in that its oxygen ion conductive phase consists of praseodymium-doped cerium oxide (composition formula: $Ce_{1-x}Pr_xO_{2-x/2}$), and its electronic conductive phase consists of spinel-type ferrite (composition formula: MFe_2O_4, where M=Mn, Fe, Co, or Ni).

3. A composite-type mixed oxygen ion and electronic conductor as set forth in claim 1 or 2, characterized in that said oxygen ion conductive phase contains a catalyst or catalysts to accelerate conversion of oxygen gas to oxygen ion or oxygen ion to oxygen, or is coated with said catalysts, or contains said catalysts and coated with said catalysts on the surface.

4. A composite-type mixed oxygen ion and electronic conductor as set forth in claim 3, characterized in that said catalyst is Ru or Ni, or their combination.

5. A composite-type mixed oxygen ion and electronic conductor as set forth in any one of claims 1 to 4, characterized in that said oxygen ion conductive phase and said electronic conductive phase, respectively consists of fine grains having diameter of 1 μm or less, are uniformly mixed with each other, and respectively form conductive networks.

6. A composite-type mixed oxygen ion and electronic conductor as set forth in any one of claims 1 to 5, characterized in that volume composition ratio of said electronic conductive phase to oxygen ion conductive phase is in the range of 5 to 40%.

7. A method of manufacturing a composite-type mixed oxygen ion and electronic conductor, characterized in that it comprises the steps of:

polymerizing by mixing metal salts of metals constituting gadolinium-doped cerium oxide, metal salts of metals constituting spinel-type ferrite, a catalyst or catalysts to accelerate conversion of oxygen gas to oxygen ion and oxygen ion to oxygen, a chelate complex, and a chelate polymerization initiator;

carbonizing said polymerized mixed phase;

dissociating carbons of said carbonized mixed phase by oxidation to obtain oxides of said metals;

grinding said metal oxides to powders; and

sintering said powders after isostatic pressing.

8. A method of manufacturing a composite-type mixed oxygen ion and electronic conductor, characterized in that it comprises the steps of:

polymerizing by mixing metal salts of metals constituting gadolinium-doped cerium oxide, metal salts of metals constituting spinel-type ferrite, a chelate complex, and a chelate polymerization initiator;

carbonizing said polymerized mixed phase;

dissociating carbons of said carbonized mixed phase by oxidation to obtain oxides of said metals;

grinding said metal oxides to powders; and

sintering said powders after isostatic pressing.

9. A method of manufacturing a composite-type mixed oxygen ion and electronic conductor as set forth in claim 7 or 8, characterized in that

said metal salts constituting gadolinium-doped cerium oxide are $Ce(NO_3)_3 \cdot 6H_2O$ and $Gd(NO_3)_3 \cdot 5H_2O$, or $Ce(NO_3)_3 \cdot 6H_2O$ and $Gd(OH)_3$,

and said metal salts constituting spinel-type ferrite is one or more salts selected from the group which consists of $Fe(NO_3)_3 \cdot 9H_2O$, $Co(NO_3)_2 \cdot 6H_2O$, $Ni(NO_3)_2 \cdot 6H_2O$, and $Mn(NO_3)_2 \cdot 6H_2O$,

and said a catalyst or catalysts is one or more elements selected from the group which consists of Ru and Ni,

and said chelate complex is anhydrous citric acid,

and said chelate polymerization initiator is ethylene glycol.

10. A method of manufacturing a composite-type mixed oxygen ion and electronic conductor, characterized in that it comprises the steps of:

polymerizing by mixing metal salts of metals constituting praseodymium-doped cerium oxide, metal salts of metals constituting spinel-type ferrite, a catalyst or catalysts to accelerate conversion of oxygen gas to oxygen ion and oxygen ion to oxygen, a chelate complex, and a chelate polymerization initiator;

carbonizing said polymerized mixed phase;

dissociating carbons of said carbonized mixed phase by oxidation to obtain oxides of said metals;

grinding said metal oxides to powders; and

sintering said powders after isostatic pressing.

11. A method of manufacturing a composite-type mixed oxygen ion and electronic conductor, characterized in that it comprises the steps of:

polymerizing by mixing metal salts of metals constituting praseodymium-doped cerium oxide, metal salts of metals constituting spinel-type ferrite, a chelate complex, and a chelate polymerization initiator;

carbonizing said polymerized mixed phase;

dissociating carbons of said carbonized mixed phase by oxidation to obtain oxides of said metals;

grinding said metal oxides to powders; and

sintering said powders after isostatic pressing.

12. A method of manufacturing a composite-type mixed oxygen ion and electronic conductor as set forth in claim 10 or 11, characterized in that

said metal salts constituting praseojymium-doped cerium oxide are $Ce(NO_3)_3 \cdot 6H_2O$ and $Pr(NO_3)_3 \cdot 6H_2O$, or $Ce(NO_3)_3 \cdot 6H_2O$ and $Pr(OH)_3 \cdot 6H_2O$,

and said metal salts constituting spinel-type ferrite is one or more salts selected from the group which consists of $Fe(NO_3)_3 \cdot 9H_2O$, $Co(NO_3)_2 \cdot 6H_2O$, $Ni(NO_3)_2 \cdot 6H_2O$, and $Mn(NO_3)_2 \cdot 6H_2O$,

and said a catalyst or catalysts is one or more elements selected from

the group which consists of Ru and Ni,

and said chelate complex is anhydrous citric acid,

and said chelate polymerization initiator is ethylene glycol.